Hazard Mitigation Funding Opportunity Approach for Coastal Resilience Projects with Ecosystem Services Methodology

Executive Summary

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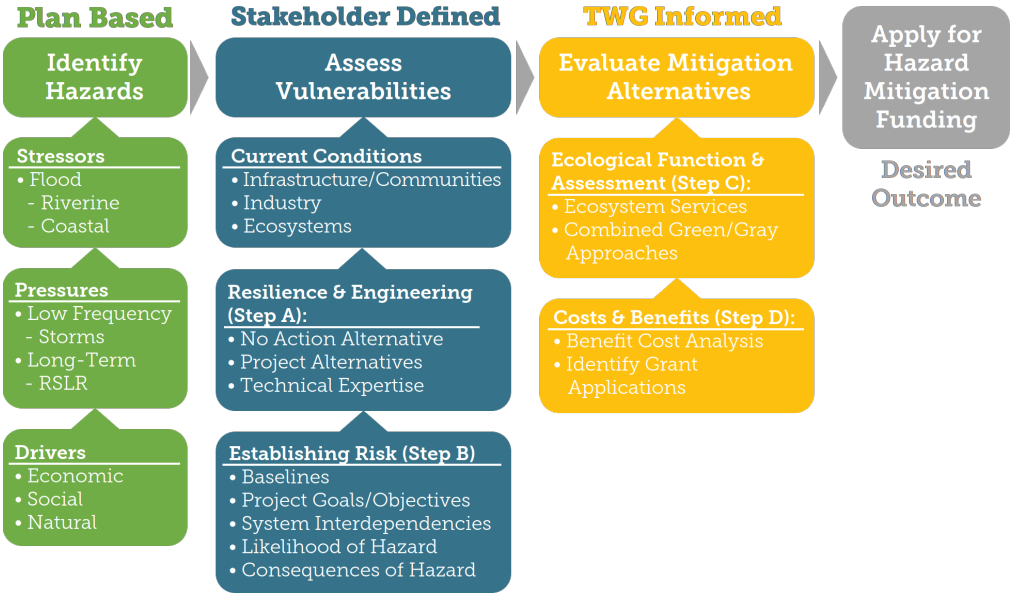
Executive Summary

This document supports the refinement and implementation of the Texas Coastal Resiliency Master Plan (TCRMP) and provides a high-level summary of the scope of the Hazard Mitigation Funding Opportunity Approach for Coastal Resilience Projects with Ecosystem Services Methodology. This document serves to outline the benefits of incorporating ecosystem services and coastal resilience components into traditional hazard mitigation projects as part of traditional Benefit Cost Analyses (BCAs) developed for federal grant opportunities.[1] This collaborative effort was developed by the GLO Planning Team and Ecosystem Services for Hazard Mitigation Technical Working Group (TWG). The TWG is composed of carefully selected experts from public agencies, private companies, and non-governmental organizations to work with the Planning Team to: (1) develop a framework to assist the GLO in understanding existing funding structures, and (2) create an approach to evaluate the natural capital benefits to implement infrastructure projects that incorporate ecosystem services.

The following framework summarizes the overall process.

Potential Benefits of this Methodology:

- Increase the role that nature-based solutions play in project decision-making to approach hazard mitigation projects comprehensively, considering both ecological and structural components.
- A more streamlined approach to account for, and secure, project funding for projects that include ecosystem services and nature-based components.
- Better integration of the benefits of ecosystem services and coastal resiliency into traditional hazard mitigation projects.



Document Structure

The organization of this executive summary is as follows:

- Introduction
- TCRMP 2018 Ecosystem Services Technical Memorandum
- Literature Review
- Hazard Mitigation Funding Approach (Steps A–D)
- Project Step-Through Example (separate document)

[1] Different funding opportunities may have different requirements for their BCAs, which should be reviewed in further detail by project proponents utilizing this approach.

Introduction

The goal of the *Hazard Mitigation Funding Opportunity Approach for Coastal Resilience Projects with Ecosystem Services Methodology* document (hereafter referred to as the main document) is to present a balanced approach to hazard mitigation funding that better integrates nature-based solutions and coastal resilience components to support project proponents in determining whether a project may be appropriate for hazard mitigation funding opportunities. By including ecosystem service concepts into conventional project planning and taking a more comprehensive approach to evaluate project benefits, the aim is to broaden the scope and technical reach of traditional hazard mitigation methods. In turn, this approach is aimed to improve the net quality of coastal hazard mitigation projects funded and designed into the future.

This methodology:

- Provides an assessment to screen projects that are potentially appropriate for hazard mitigation funding opportunities,
- Identifies and defines potential areas of risk along the Texas coast where nature-based hazard mitigation projects might be most beneficial,
- Describes the benefits of the ecological components of projects through characterization of their main ecosystem service functions, and
- Identifies potential target hazard mitigation funding opportunities for selected projects.

The remainder of this document frames the methodology that was developed by the Planning Team in conjunction with the TWG.

Ecosystem Services Technical Memorandum

The *2018 TCRMP Ecosystem Services Technical Memorandum* (hereafter, memorandum) was developed for the 2019 TCRMP and highlighted economic valuations of ecosystem services for the Texas coast at the ecosystem (habitat type) level. The memorandum was used as the basis of this methodology and is included in full within the broader methodology document (pages 2-1 to 2-26 of the main document). More specifically, the memorandum enhanced and built upon relevant literature and databases while considering regional and/or sub-regional characteristics that might influence how ecosystem services are represented at specific locations along the Texas coast. The memorandum can also be found in the 2019 TCRMP Technical Report.

Ecosystems and their associated services have economic values for society because people derive utility from their actual or potential uses, as well as from motivations not connected with use (such as altruism, bequests, and stewardship). Assigning an economic value to ecosystem services is challenging – conventional economic valuation traditionally considers provisioning services that are considered to have a market value (i.e., the products that can be harvested and sourced from an ecosystem, such as timber or food). Yet, ecosystems provide many other services benefitting humans either directly or indirectly, such as regulating, cultural, and supporting services.

To further explicate how they are monetized for specific Texas coastal habitats, ecosystem service benefits can be categorized into four broad service groups (definitions can be found on page 2-2 of the main document):

- **Provisioning services** include food, raw materials, and medicinal resources provided by ecosystems that can be used by people.
- **Regulating services** are provided by ecosystems that act as regulators, such as regulating air quality, water quality, and heat, moderating extreme events, preventing erosion, and acting as biological control.
- **Supporting services** are provided by the habitats that enable flora and fauna to survive, and include supports such as food, water, and shelter. Supporting services may also include the maintenance of biogenetic diversity.
- **Cultural services** include the recreational value of ecosystems, such as the aesthetics, tourism, and spiritual experiences provided by ecosystems.

Summary of Methods

A benefits transfer approach using meta-analyses on a national or global scale was applied to select coastal habitats in an attempt to refine the ecosystem service valuations from the aforementioned memorandum, except when studies specific to the Texas or Gulf Coast were available. Since there are a limited number of ecosystem services studies conducted for Texas and neighboring states, average national/global values were used to estimate the values of specific ecosystem services. The estimated benefits transferred from other studies were then adapted to the Texas coast and adjusted for inflation to 2018 dollars.[2]

The value of ecosystem services provided by habitats is highly contextual and unique to each habitat which can make valuation difficult when comparing across different environmental conditions and landscapes. Ecosystem services from seven target habitat types (described in detail on pages 2-3 to 2-26 of the main document) were evaluated along the Texas coast, and include:

- Oyster Reefs
- Coastal Wetlands
- Coastal Bottomland Forests
- Mangroves
- Coastal Prairies
- Beaches and Dunes
- Seagrass

These habitat types were evaluated based on the four above-mentioned ecosystem services categories and best available scientific data.

Summary of Results

The seven habitats were valued for their respective ecosystem services in coastal Texas and a high-level discussion of the findings are provided below. Most habitats are likely underestimated in terms of the ecosystem services they provide. They represent conservative values intended as high-level estimates and do not necessarily encapsulate the full range of ecosystem services for the Texas coast. It is expected that there is a high level of uncertainty associated with these estimates due to the limited availability of data, extrapolating information from preexisting studies, variability of habitats across the landscape, etc.

Oyster Reefs: Oyster reefs (pages 2-3 to 2-6 of the main document) provide provisioning services and nutrient control, unless highly degraded. In addition, the health and location of oyster reefs should be considered when valuing its regulating (erosion control), supporting (providing habitat), and cultural services (recreational fishing).

Coastal Wetlands: The monetized benefit values reported for coastal wetlands apply to healthy habitats, with the exception of storm protection services, which applies to wetlands located near flood prone infrastructure. Additional information regarding coastal wetlands can be found on pages 2-6 to 2-9 of the main document.

Coastal Bottomland Forests: Ecosystem services for Texas coastal bottomland forests (pages 2-9 to 2-11 of the main document) include regulating services, in the form of nutrient control, and water regulation, depending if the habitat is situated in an urban or rural area. Supporting services vary greatly due to the abundance of rare species associated with this habitat type.

Mangroves: The values monetized for mangroves were based on meta-analyses and apply to healthy mangroves, with the exception of storm protection services, which only apply to mangroves located near infrastructure at risk for flood damage. Mangroves also provide supporting (nutrient cycling, food production, habitat, and biodiversity) and cultural services (recreation and eco-tourism). More information can be found on pages 2-11 to 2-14 of the main document.

Coastal Prairies: The ecosystem service values that were monetized for coastal prairies were based on meta-analyses or studies conducted in Texas and neighboring states with similar prairie habitats. Coastal prairies occupy

[2] Although some habitats may be difficult to distinguish, it is important to designate each acre (or fraction of an acre) as a specific habitat type to prevent double-counting benefits.

less than 1 percent of the Texas coastal region but are known to supply provisioning services, (grazing land and hunting). For more information regarding coastal prairies, see pages 2-14 to 2-16 of the main document.

Beaches and Dunes: Beaches and dunes (pages 2-16 to 2-18 of the main document) are associated with cultural services (recreation and tourism) and also provide regulating services through erosion control and protection from coastal storms.

Seagrass: Seagrass habitats are one of the most productive ecosystems in coastal Texas and support all four categories of ecosystem services. Additional information can be found on pages 2-18 to 2-21 of the main document. Meta-analyses were used to value seagrass ecosystems, given that current economic valuations are very limited and incomplete, and resulted in grossly undervalued seagrass beds.

Ecosystem Services Summary Table

Habitat Type	Average Annual Value per Hectare per Year
Oyster Reefs	$114,300 - $224,400
Coastal Wetlands	$37,200 - $53,800
Coastal Bottomland Forests	$28,900 - $39,700
Mangroves	$225,500 - $231,900
Coastal Prairies	$15,500
Beaches	$47,900 - $131,000
Dunes	$13,000 - $96,100
Seagrass	$64,900

Note: All values rounded to the nearest hundred and based on 2018 dollars.

Literature Review

A literature review of available data relevant to the Texas coast was performed to (1) build upon the aforementioned 2018 memorandum, and (2) assess the extent of research conducted on ecosystem services, their benefits, techniques applied to evaluate them, and online tools available for valuing ecosystem services. An overview of the approach and methods to value ecosystem services are discussed herein. To view the entire Literature Review, see pages 3-1 to 3-32 of the main document.

Approach to Value Ecosystem Services

The following factors should be considered when designing a valuable ecosystem valuation exercise:

- Define the scope of the analysis and consider which ecosystem services will be included or excluded, by choice or necessity, in the valuation process.
- Define the geographic extent of the relevant ecosystems for the valuation process.
- Define the relevant stakeholders – identifying and including relevant stakeholders in the valuation analysis will improve the valuation estimate.[3,4]

[3] National Research Council (NRC). 2005. Valuing Ecosystem Services: Toward Better Environmental Decision-Making. Report of the Committee on Assessing and Valuing the Services of Aquatic and Terrestrial Ecosystems National Academies Press, Washington, D.C., 274 pp. (ISBN: 978-0-309-13345-6).
[4] Pascual, U., Muradian, R., Brander, L., Gómez-Baggethun, E., Martín-López, B., Verma, M., Armsworth, P., Christie, M., Cornelissen, H., Eppink, F. and Farley, J., 2010. The economics of valuing ecosystem services and biodiversity: The Ecological and

It is important to remember that no valuation technique is perfect. For any valuation effort, the requirements of the analysis will be influenced by the resources and data available, and uncertainty will always be a concern.[5]

Methods of Economic Valuation of Ecosystem Services

To gain one step toward valuing ecosystems services along the Texas coastline, the Literature Review dives deeper into the Total Economic Value framework, preference-based economic valuation, and other methods currently in practice. Below are high-level discussions of each topic area discussed in detail in the full methodology.

Total Economic Value Framework

The Total Economic Value (TEV) framework (explained in greater detail on pages 3-8 to 3-10 of the main document) assesses both market and non-market values of ecosystem services.[6] TEV is a concept in BCAs where humans derive a value from having ecosystem services as compared to not having those services. The TEV framework aggregates the values of all services provided by a habitat that are generated now, and in the future.[4]

Preference-Based Valuation

Preference-based approaches (pages 3-10 to 3-11 of the main document) are widely accepted for valuing ecosystem services and rely on observing human behavior and estimating value from individual choices. [4] The primary objectives of preference-based valuation are to determine stakeholder preference, how much stakeholders are willing to pay for a service, and to what degree they would consider themselves to be better or worse off due to any changes in the provision of a service. [7]

Conventional preference-based economic valuation includes two primary methods for estimating value and requires significant time and resources to gather pertinent data:

1. *Revealed Preference* methods are based on observed human behavior in a real-world setting. The method analyzes human choices and deduces a value from these observed choices.
2. *Stated Preference* methods rely on analyzing individual responses to carefully designed survey questions. The method includes using contingent valuation and choice experiments.

Benefit Transfer

When revealed and stated preference methods are not possible, the benefit transfer method is an additional option, but has greater error rates (more information on this approach can be found on pages 3-11 to 3-12 of the main document). Benefit transfer uses research results from primary valuation studies at one site and transfers the results to other, similar sites.[8] It is also a means to aggregate calculated values to larger spatial scales and contexts.[5]

Use of Proxies

For some ecosystem services that are difficult to quantify, such as regulating or supporting services, proxy measures have been useful to estimate economic values (more information on pages 3-12 to 3-13 of the main document).[5] For example, Net Primary Productivity (NPP) – the rate energy is stored as biomass by primary

Economic Foundations. Chapter 5. Available at: http://africa.teebweb.org/wp-content/uploads/2013/04/D0-Chapter-5-The-economics-of-valuing-ecosystem-services-and-biodiversity.pdf

[5] Costanza, R., De Groot, R., Braat, L., Kubiszewski, I., Fioramonti, L., Sutton, P., Farber, S. and Grasso, M., 2017. Twenty years of ecosystem services: how far have we come and how far do we still need to go? Ecosystem services, 28, pp.1-16.

[6] Ledoux, L. and Turner, R.K., 2002. Valuing ocean and coastal resources: a review of practical examples and issues for further action. Ocean & Coastal Management, 45(9-10), pp.583-616. Available at: https://iwlearn.net/files/pdfs/Ledoux_Turner%202002_Valuing%20ocean%20and%20coastal%20resources.pdf

[7] Wood, M.D., Kumar, P., Negandhi, D. and Verma, M., 2010. Guidance manual for the valuation of regulating services. University of Liverpool for United Nations Environment Programme.

[8] Olander, L., Tallis, H., Polasky, S. and Johnston, R.J., 2015. Best practices for integrating ecosystem services into federal decision making. Duke University, National Ecosystem Services Partnership. 48 pp. Available at: https://nicholasinstitute.duke.edu/sites/default/files/publications/es_best_practices_fullpdf_0.pdf

producers for other consumers in the trophic food web – provides a good proxy for ecosystem services. [9] Additionally, oyster reefs can be substituted as a proxy for shoreline protection when compared to protection using traditional gray infrastructure.[10]

Biophysical Valuation

Biophysical valuation (page 3-13 of the main document) refers to the 'cost of production' approach, which considers the sum of the cost of resources that goes into producing a good or service (i.e., labor, energy, or material inputs) to maintain a specified ecological state. [4] This approach considers the physical costs of maintaining a particular ecological state, and therefore is more useful for valuing natural capital stocks that have a biophysical form than for valuing indirect services like storm protection. Biophysical valuation relies heavily on implicit assumptions (i.e., ecosystem services with direct biophysical expression irrespective of the value for humans, or cultural services provided) and, therefore, is not a common method for valuing ecosystem services.

Identifying Nature-based Projects for Hazard Mitigation Funding

The approach outline provided on pages 4-1 to 4-4 of the main document gives a description of each step in the process to identify prospective projects that could be used to apply for hazard mitigation grant funding. The steps included in the approach (Steps A to D) are meant to guide project proponents through selecting a nature-based project that meets minimum criteria to be eligible for funding (Step A); meets certain risk thresholds for sea level rise, flooding, and wave effects (Step B); provides ecosystem services (Step C); and can be tailored for one or more hazard mitigation funding grant opportunities (Step D). These steps are described, in brief, below.

Step A - Project Assessment

During Step A (pages 5-1 to 5-2 of the main document), projects are systematically screened to determine whether each project would be appropriate for hazard mitigation funding under federal and/or other grant funding opportunities. Projects can be determined to be potentially appropriate while including ecosystem service benefits by answering several simple questions.

Step B - Risk Index

During Step B (pages 6-1 to 6-8 of the main document), sites that are vulnerable to coastal hazards will be identified. For a project to be considered more appropriate for hazard mitigation funding opportunities, the project site would need to have developed areas that are vulnerable to hazards that would be mitigated under the funding source (e.g., flooding in the case of a Federal Emergency Management Agency [FEMA] Flood Mitigation Assistance grant). The risk index may be used to help a project proponent (1) select a location for a proposed project that would likely be appropriate for hazard mitigation funding, or (2) decide if a pre-determined project location is a good candidate for a hazard mitigation project.

Risk index maps are included for each hazard and allow project proponents to determine the level of risk at each proposed project site:

- Landcover change due to future sea level rise projections (Figures 6-4 to 6-7 in the main document)
- Inundation due to 1% annual chance storm (100-year storm) FEMA National Flood Hazard maps (Figures 6-8 to 6-11 in the main document)
- Wave exposure (Figures 6-12 to 6-15 in the main document)

[9] Costanza, R., d'Arge, R., De Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J. and Raskin, R.G., 1998. The value of ecosystem services: putting the issues in perspective. Ecological economics, 25(1), pp.67-72. Available at: http://www.robertcostanza.com/wp-content/uploads/2017/02/1998_J_Costanza_ESvalue.pdf

[10] Henderson, J. and O'Neil, J., 2003. Economic values associated with construction of oyster reefs by the Corps of Engineers (No. ERDC-TN-EMRRP-ER-01). ENGINEER RESEARCH AND DEVELOPMENT CENTER VICKSBURG MS. Available at: https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.553.4035&rep=rep1&type=pdf

Step C - Value of Ecosystem Services

Step C (pages 7-1 to 7-50 of the main document) will aid a project proponent in describing the benefits of the ecological components of the proposed project. This will be done by characterizing the project by its main ecosystem service functions, such as habitat, biodiversity (species richness), primary productivity, provisioning services, and carbon sequestration. When data is available, quantified benefits may be transferred to the project based on regionally specific monetary valuations of the benefits of ecosystem services. Any benefits that cannot be determined quantitatively can be discussed qualitatively in a grant funding application.

Step D – Synthesis of Results and Hazard Mitigation Application

After completing the preceding steps, Step D (pages 8-1 to 8-7 of the main document) provides a synthesis of the information determined in Steps A to C. The template table below is provided to record and evaluate the results of each step and can be used to organize the relevant hazard mitigation application information (more detailed information on how to use the table can be found on page 8-4 in the main methodology document).

Step D also includes a list of potential hazard mitigation funding opportunities (pages 8-5 to 8-7 of the main document) that have been identified to help a project proponent determine potential opportunities that may be available for funding applications for the selected project.

Project Step-Through

The project step-through is a separate document meant to serve as a guide for project proponents to walk through the intricacies of determining the responses to Steps A to C for a specific project example.

Conclusion

This document serves to supplement the *Hazard Mitigation Funding Opportunity Approach for Coastal Resilience Projects with Ecosystem Services Methodology* and is intended to clarify and streamline the approach process for project proponents looking to apply for and secure hazard mitigation funding for nature-based resiliency projects in coastal Texas. Specifically, the methodology document aims to support project proponents in determining the appropriateness of a particular project as a nature-based solution for hazard mitigation funding, the level of exposure to particular hazards that could be at the project site, and the ecosystem service benefits that could result after project implementation.

Step A		Step B					
General Project Assessment	Y/N	Risk index score (check box for each)					
Does the project reduce loss of life and property by minimizing natural disaster impacts (e.g., coastal or riverine flooding)?		Hazard	Low	Low-Medium	Medium	Medium-High	High
Does the project enhance, create, or support ecosystems through avoided damages (i.e., is the project a nature-based solution)?		Land Loss Risk Index					
Is the project in need of funding? *(partially funded or not funded)*		Flood Risk Index					
Is the project in an early planning phase? *(conceptual, preliminary design, permitting, final design, shovel ready)*		Wave Action Risk Index					
If a "yes" response is achieved for each question, proceed to Step B.		If the project achieves a medium to high score for at least one hazard, proceed to Step C.					

Step C									
Regulating services score		Co-benefits score							
Regulating services	**Score**	**Regulating services**	**Score**	**Supporting services**	**Score**	**Cultural services**	**Score**	**Provisioning services**	**Score**
Storm surge / Flooding protection		Carbon sequestration		Habitat provision		Ecotourism		Fisheries / Grazing / Timber	
Erosion control / Shoreline stabilization				Species richness		Recreation			
Project alignment questions				Listed species					
				Critical habitat					
				Primary productivity					
Total score									
Notes									

Note: See Section 8 of the main document for additional information.